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# The Autosegmental-Metrical Prosodic Structure: not fit for French?

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## Abstract

Since two decades at least, intonation phonology is almost exclusively dominated by the Autosegmental-Metrical model, which appears universally appropriate to describe sentence intonation in most languages. However, careful examination of the AM limitations and drawbacks may question this universality, leading way to improve and possibly modify key properties of this theoretical approach, at least for languages such as French.

**Index Terms:** sentence intonation, autosegmental-metrical, ToBI, prosodic structure, French.

## 1. Introduction

Since two decades at least, the so-called Autosegmental-Metrical (AM) model [1] has been dominant in intonation phonology. In this model, the prosodic structure organizes hierarchically prosodic events (PE) in three non-recursive levels: a first level assembles syllables  $\sigma$ , content words Wc (verbs, nouns adjectives and adverbs) and function words Wf (conjunctions, pronouns,...) into accentual phrases (AP); a second level groups AP into intonation phrases (IP) (Fig. 1); finally a phonological utterance (PU) eventually groups sequences of IP.

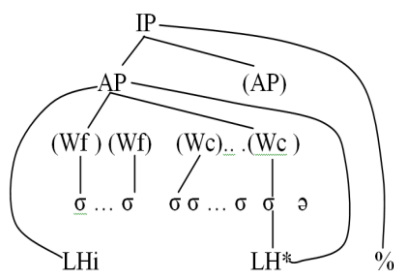


Figure 1. Autosegmental-Metrical prosodic structure [1]

The prosodic events PE are aligned on accentual phrases specific syllables and are described as sequences of tones belonging to the ToBI notational system (tones and break indices). This system uses High (H) and Low (L) symbols to transcribe melodic targets as perceived or observed on fundamental frequency curves obtained from the speech signal acoustic analysis.

Since the AM approach is widely used on many languages other than English (Japanese [2], Korean [3], Dutch [4], German [5], Italian [6], French [7], etc.), one may think that it carries some universal value by capturing in its essence basic characteristics of sentence intonation of so many languages. However, open or allusive critics have been emerging for some time (e.g. [8]) leading to a more serious analysis of the AM limitations and drawbacks, and these critics may apply particularly to French.

## 2. Anything wrong with the AM Prosodic Structure?

Indeed, since the AM approach is so widely used in intonation sentence phonology and applied to many different languages, what could be wrong with it? I will try to enumerate a few possibly questionable points:

- The AM prosodic structure is non-recursive. This property has already been discussed by various authors, and among other reasons originates in my opinion from the fact that very short sentences were used as experimental justification for this property. Indeed, exclusive use of limited length sentences prevents the observation of recursiveness, even in English [10];
- Descriptions of prosodic events underlying a prosodic structure do not take duration parameters into account. The ToBI system has no explicit provision to describe temporal aspects of sentence intonation other than the perceived break durations (which is seldom used);
- While other transcription systems are either available or could be more or less easily adapted to fit specific properties of a given language, the quasi exclusive use of the ToBI system involves an oversimplification of the description of melodic events, oversimplification sometimes compensated at a later stage by complex tone alignment rules aimed to better take the phonetic details of melodic movements into account;
- In many instances, confusion exists between phonological and phonetic descriptions of prosodic events. Some authors give PE descriptions so detailed that they appear purely phonetic rather than phonological (e.g. [12]);
- Contextual properties of prosodic events are often ignored, as there seem to be a strong underlying assumption that prosodic events share properties similar to phonemes. This aspect is intriguing, as the AM approach was proposed to address the possible effect of context in the realization of melodic contours. Contextual rules may appear only on the surface structure, but are generally not considered as an inherent property of PE;
- In early versions of the AM framework, the prosodic structure was assumed to be congruent with the sentence syntactic structure. This implies that only

one prosodic structure could be associated to a given sentence. Even if congruence with syntax is not necessarily retained today as an hypothesis, it is rare to find an author considering the possibility to associate more than one prosodic structure to a given syntactic structure. A notable exception can be found in [9];

- g. As other less known theoretical approaches, AM ignores a basic property of sentence intonation, i.e. to be encoded by prosodic events encoded and decoded sequentially by the speaker and the listener. Therefore, it may be misleading to consider prosodic events on a piece of paper as emerging at once to represent the prosodic structure, as they appear in reality in a timely fashion one after the other. This time domain dynamic aspect may modify the way we envision sentence intonation and the prosodic structure [16];
- h. A last point pertains to the quasi exclusive use of laboratory speech, generally involving (very) short sentences. This limited choice of data, justified in the early years by technical limitations, prevents the AM prosodists to observe data that would seriously question the use of their approach.

I will now discuss in some details these points, while trying to suggest possible modifications and improvements.

### 3. AM intonation phonology and French experimental data

#### 3.1. The AM prosodic structure is non-recursive

Critics of the non-recursive constrain appear as early as 1986 (see Ladd [8]), but this author later revised his opinion on the recursiveness of the prosodic structure [10]. In a recent work on French sentence intonation [11], despite the use of very short sentences in the experiment presented in this study, the need for at least an intermediate IP appears clearly. This point can be also shown by comparing the two following examples in French:

- a) *Le marin roumain n'aurait pas voulu ranimer la jolie maman.*  
(The Romanian sailor would not have wanted to revive the beautiful mother).
- b) *Si le rat marron avait voulu manger le long mulot le marin roumain n'aurait pas voulu ranimer la jolie maman.*  
(If the brown rat had wanted to eat the long field mouse the Romanian sailor would not have wanted to revive the beautiful mother).

By adding the relative phrase *Si le rat marron avait voulu manger le long mulot* in front of sentence a) reveals the need to consider at least one extra level in the prosodic structure,

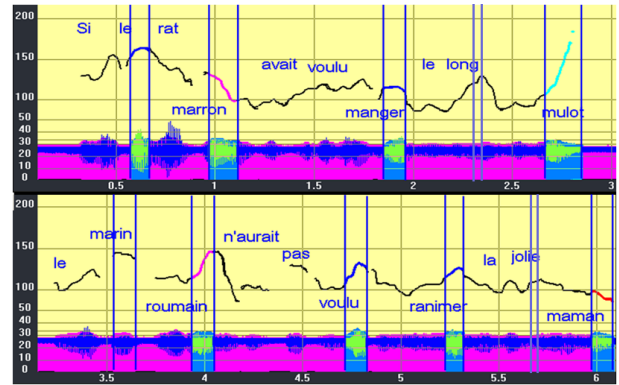


Figure 2. Melodic curve of the French example « Si le rat marron avait voulu manger le long mulot le marin roumain n'aurait pas voulu ranimer la jolie maman » with the stressed syllables between vertical cursors highlighted.

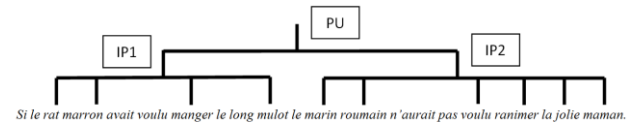


Figure 3. The AM prosodic structure of the example of Fig. 2 with both IP's at the same level.

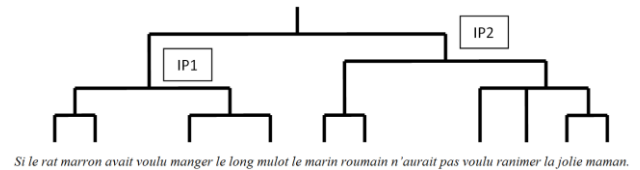


Figure 4. The prosodic structure of the example of Fig. 2 as indicated by the melodic contours system of contrasts. Extra levels are needed to adequately represent the structure encoded by the melodic contours.

Indeed, *si le rat marron* and *avait voulu manger le long mulot* appears as second level IP's grouped into a first level IP *Si le rat marron avait voulu manger le long mulot*. Prosodically, *marron* bears a falling melodic contour whereas the contour on *roumain* is rising, indicating the existence of two IP's (Fig. 4).

#### 3.2. The ToBi transcription does not transcribe duration

Since ToBI notation system uses only combinations of High and Low tones, no provision is made to represent possible contrasts in duration or in amplitude of melodic variation that would differentiate prosodic events. Rhythmic factors are also absent from the transcription, except indirectly through the scale of breaks (which are based on perception). Fig. 5 shows how two melodic contours of different durations and melodic variation can be transcribed by the same sequence of tones.

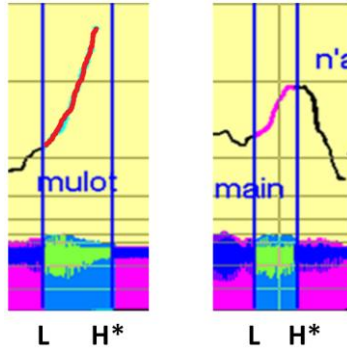


Figure 5. The same L H\* ToBI tone sequences transcribe contours with different durations.

### 3.3. ToBI use with the AM prosodic structure tend to confuse phonetic and phonology

Since the AM prosodic structure has by definition only two levels, only three phonologically distinct prosodic events should a priori be considered to encode this structure. However, in many studies, phonetic details of the melodic curve are given by defining the position of the High or Low target tone inside the stressed syllable.

The transcription of the prosodic event on the stressed syllable of *marron* and *roumain* in the example of Fig. 6 can be phonological by using H\* in both cases but aligned on the beginning of the syllable for *marron*, and H\* aligned on the end of the syllable for *roumain*. In either case, the alignment of the target H or L can give a proper account to either a rising or falling melodic contour by selecting an adequate phonetic alignment on the left or the right syllable boundary. Although this can describe data properly, it fails to capture the contrast of melodic slope, characteristic of French intonation [16].

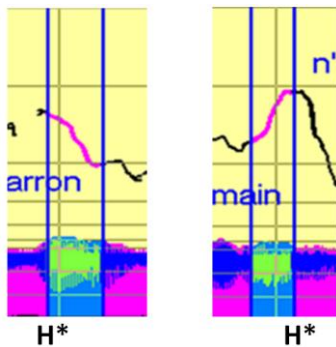


Figure 6. The same L H\* ToBI tone sequences transcribe contours with rising or falling melodic slope.

### 3.4. In the AM approach only one prosodic structure can be associated with a given syntactic structure

In most if not all AM studies it is assumed that only one prosodic structure can be assigned to a given text (or a given syntactic structure). Still factors like eurhythmicity are clearly interacting in the speaker realization, and this is particularly obvious in French. In *Marion adore le whisky écossais* (“Marion loves Scotch whisky”) for example, prosodic phrasing can be [Marion] [adore le whisky écossais] (syntactic alignment) as well as [Marion adore] [le whisky écossais]

(eurhythmic alignment). More than one prosodic phrasing are then possible for this example (Fig. 7).



Figure 7. Two prosodic structures that can be associated with the same sentence “Marion adore le whisky écossais”.

### 3.5. The AM approach does not provide for the dynamic time aspects of the prosodic structure

In the AM framework, the sentence prosodic structure is viewed globally, taking into account all the prosodic events at once from the beginning to the end, without taking into account the sequence of events in function of time.

However, from the point of view of the speaker and the listener, the situation is quite different: whereas the speaker can achieve some planning ahead in the production of the prosodic structure, it is barely the case for the listener, who has to process the linguistic information from the sequence of units perceived one by one along the time scale. In this process, prosodic events are used as signals triggering partial processing of the already perceived syllables, by concatenation of strings of already stored units to form larger syllabic groups organized in stress groups. This process is totally absent in the AM framework.

### 3.6. Examples of laboratory speech given in the AM literature are too short

The apparent justification to limit to two the number of levels of the AM prosodic structure may stem from the fact that laboratory speech analysis of sentence intonation was performed on short sentences with a limited syntactic complexity.

In French for instance, examples analyzed in AM studies could be as simple as *Marion mangera des bananes* (“Marion will eat bananas”) [3], *Le mari d’Amanda réclamait sa bicyclette* (“Amanda’s husband reclaimed his bicycle”) or *Marie a rencontré les amis de Rémy dans la journée* (“Mary met Rémy’s friends in the afternoon”) [11]. Likewise, in Italian, complex studies were carried on sentences like *Mamma andava a ballare da Lalla* or *Io dicevo mamma* [12]. In Spanish, *Cuando hubo hablado, Juan se fue* or *Le dieron el número de vuelo* [13].

The analysis of this kind of examples obviously prevents the observation of a prosodic structure with more than one level IP. It is time for the AM approach to confront the theory to more realistic data.

### 3.7. Transcription as theory

Badiou [14] and Ochs [15] demonstrated that the choice of a transcription system determines the theory that uses this system, whereas, in linguistics in particular, it should be the reverse: the models derived from a theory should determine the transcription system to analyze the experimental data.

It appears rather obviously that the ToBI transcription system acts as a filter retaining only selected parts of the information present in the data. For example when for a language such as French, prosodic events may contrast by the

range of variation of melodic contour or by a concave shape; these differences cannot be easily captured with a combination of the available symbols H and L and their variants.

By specifying the alignment of the tonal target inside the syllable, it is possible, although in a not very intuitive way, to give an account for complex Fo curved shapes. A recent encounter to define a French ToBI set of contours held in Tarragona [17] revealed the difficulty to obtain satisfactory set of prosodic events description for French using ToBI symbols.

To summarize, the use of ToBI system not only filters the data, but obscures the explanation principles underlying the concept of prosodic structure applied to the sentence.

### 3.8. The AM approach is short in explanation principle

The AM prosodic structure lacks a convincing explanation principle: what it tells us phonologically is that intonation sentence assembles prosodic words (equivalent to AP) in two levels. Therefore, the only possible falsification test to ensure the AM approach is not tautological consists to demonstrate that indeed only two levels are found in the prosodic structure of any language.

Furthermore, no explanation is proposed pertaining to the phonological role of the melodic contours as described by ToBI notation in the indication of the structure. Prosodic words and their contours actually appear independent from the structure that organize their hierarchy in the sentence, whereas it may seem intuitively (and demonstrated by careful data analysis) that indeed melodic contour act as indicator of the prosodic structure [16]. Furthermore, when the prosodic structure becomes more complex, the contrasts between the realizations of melodic contours become more elaborate and involve more phonetic features, an easily observable fact that is not taken into account by the AM approach.

## 4. Conclusions

The prosodic structure as defined in the Autosegmental-metrical approach operates as a filter allowing the phonologist and possibly the phonetician to select pertinent characteristics from the complexity of prosodic data, fundamental frequency, duration and intensity as revealed by acoustical analysis. As such, it allowed a new generation of researchers to enter the relatively new field of prosody offered by the development of computer technology and the availability of acoustic analysis software such as Praat or WinPitch.

Still the time has come to go beyond the AM approach to take into account new insights given by a critical analysis of the properties and limitations of the AM prosodic structure. In particular, the point of view of the listener and the relative independence of syntax as revealed by spontaneous speech data should definitely enter in a new theoretical approach of sentence prosody and phrasing.

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